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FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER **L9289.01164**
		U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 09/890356
INTERNATIONAL APPLICATION NO. **PCT/JP00/08151**	INTERNATIONAL FILING DATE **November 20, 2000**	PRIORITY DATE CLAIMED **December 6, 1999**

TITLE OF INVENTION
COMMUNICATION TERMINAL APPARATUS AND RADIO COMMUNICATION METHOD

APPLICANT(S) FOR DO/EO/US
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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Claim for Priority with PCT/IB/304
PCT/IB/308
PCT/RO/101

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24. The following fees are submitted:.	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	12 - 20 =	0	x $18.00	**$0.00**	
Independent claims	10 - 3 =	7	x $80.00	**$560.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$1,420.00**	
☐ Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$0.00**	
SUBTOTAL =				**$1,420.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$1,420.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☒				**$40.00**	
TOTAL FEES ENCLOSED =				**$1,460.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$1,460.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ____________ in the amount of ____________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **19-4375** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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DESCRIPTION

COMMUNICATION TERMINAL APPARATUS AND RADIO COMMUNICATION METHOD

Technical Field

The present invention relates to a communication terminal apparatus and radio communication method in a digital radio communication system, and more particularly to a communication terminal apparatus and radio communication method in a DS-CDMA (Direct Sequence-Code Division Multiple Access) system.

Background Art

In a mobile communication the received signal quality deteriorates extremely due to fading. There exists a diversity technique as an effective method for the fading. The diversity technique is to prevent received signal power from falling on a receiver side. However, there are various restrictions to achieve the diversity in a communication terminal apparatus such as a mobile station. Therefore, in order to achieve on a transmitter side of a base station the diversity that is originally expected to be achieved on a receiver side of the mobile station, transmission diversity has been examined.

In the transmission diversity, as illustrated in FIG.1, base station 1 transmits signals of the same phase

from antennas 1 and 2 to mobile station 2, and mobile station 2 selects a received signal with a higher level transmitted from one of the antennas.

Meanwhile, in the DS-CDMA system, the standardization of the transmission diversity is promoted currently that a base station uses closed-loop transmission diversity. There are three modes in the closed-loop transmission diversity. For example, when mode 2 of the closed-loop transmission diversity is applied, a base station provides a signal of antenna 2 with phase rotation (90° shift) with respect to a signal of antenna 1 to transmit. Using signals transmitted from antennas 1 and 2, the mobile station judges a phase difference to be provided between the both signals, and transmits the phase difference information to the base station. The base station transmits signals according to the phase difference information. This processing is executed for each slot. Therefore, the mobile station receives signals with a phase rotated greatly for each slot.

With reference to FIGs.2 to 8, phases of received signals will be described below that are received at a mobile station when a base station applies mode 2 of the closed-loop transmission diversity.

The base station transmits common pilot channel signals (common known signals) of the same phase from antennas 1 and 2. At this point, the common pilot channel

signal transmitted from antenna 1 is spread with a different spreading code from a spreading code that is used in the common pilot channel signal transmitted from antenna 2.

In transmitting communication channel signals from the base station, since the phase rotation control is not performed at a general condition that is not of the closed-loop transmission diversity, the base station transmits the signals to the mobile station using only antenna 1. In the closed-loop transmission diversity, as illustrated in FIG.6, a signal to be transmitted from antenna 2 is provided with a phase designated by feedback information transmitted from the mobile station, and thereby the phase rotation control is performed to transmit signals.

When the mobile station receives the signals thus transmitted from the base station, since with respect to common pilot channel signals, different signals are transmitted from antennas 1 and 2, channel estimation is capable of being performed for each transmission antenna. In other words, as illustrated in FIG.3, the mobile station receives signals with different phase rotations respectively from antennas 1 and 2, and therefore channels are estimated separately on the common pilot channel signal transmitted from antenna 1 and the common pilot channel signal transmitted from antenna 2.

Based on the two channel estimation values, the

mobile station determines a phase difference to be provided between signals to be respectively transmitted from antennas 1 and 2, and then notifies the base station of the phase difference (feedback information).

The setting of the feedback information is herein explained.

As described above, the base station transmits the common pilot channel signals respectively using antennas 1 and 2. The mobile station performs the channel estimation on the common pilot channel signals, and thereby is capable of calculating a phase rotation amount and amplitude variation due to fading on each of antennas 1 and 2.

As illustrated in FIG.2, when the base station transmits common pilot channel signals with the same amplitude and same phase (phase=0) respectively from antennas 1 and 2, the mobile station receives signals as illustrated in FIG.3. In FIG.3, α is indicative of the phase rotation due to fading provided on the transmission signal from antenna 1, while β is indicative of the phase rotation due to fading provided on the transmission signal from antenna 2.

As illustrated in FIG.4, when the base station transmits communication channel signals with the same amplitude and same phase (phase=0) respectively from antennas 1 and 2, the mobile station receives signals as illustrated in FIG.5. In FIG.5, A is indicative of

an amplitude variation due to fading provided on the transmission signal from antenna 1, while B is indicative of an amplitude variation due to fading provided on the transmission signal from antenna 2. In the mobile station, signals transmitted from antennas 1 and 2 are combined and received as a signal indicated by a bold arrow as illustrated in FIG.5. At this point, the phase of the combined vector is Φbefore.

In this case, since $\beta - \alpha$ is about 90°, it is expected that rotating the phase of a signal from antenna 2 by -90° increases the combined vector composed of the signals transmitted antennas 1 and 2. Therefore, the phase of a signal from antenna 2 is set to -90°, and the mobile station notifies the base station of feedback information (phase difference) for requesting the base station to transmit the signal with the phase difference.

When the feedback information is notified to the base station correctly, a communication channel signal is transmitted on a next slot as illustrated in FIG.6. In other words, the signal with a phase shifted -90° is transmitted from antenna 2. As a result, the mobile station receives signals as illustrated in FIG.7. At this point, the phase of the combined vector is Φafter. Accordingly, even when the fading environment does not change, in the mobile station a phase shift is caused like Φafter and Φbefore due to the phase addition in antennas on a transmitting side.

On the communication channel of the mobile station, by increasing channel estimation accuracy, control is performed that channel estimated results of a plurality of slots are weighted to be added. This control is performed on the assumption that a phase rotation amount due to a fading variation is small with respect to the number of slots whose channel estimated results are added. However, as described above, when the closed-loop transmission diversity is applied, since the channel estimation value varies even when the fading does not varies, it is not possible to calculate an accurate channel estimation value by averaging channel estimation values of a plurality of slots to use, and thereby reception performance deteriorates.

Disclosure of Invention

It is an object of the present invention to provide a communication terminal apparatus and radio communication method enabling excellent reception performance without deterioration of channel estimation accuracy even in transmission diversity using closed-loop transmission diversity.

The inventors of the present invention paid attention to that in the closed-loop transmission diversity, when a phase rotates due to the transmission diversity control, a communication terminal notifies feedback information (phase rotation amount) to a base

station on a last slot, and that the communication terminal knows a phase difference to be provided between corresponding slots to be transmitted respectively from antennas 1 and 2, found out that the communication terminal is capable of performing accurate channel estimation even in the closed-loop transmission diversity by correcting a received signal using the known phase difference, and carried out the present invention.

That is, it is a gist of the present invention that in the closed-loop transmission diversity, a communication terminal apparatus calculates a phase correcting value for compensating for an effect of the phase rotation due to the transmission diversity, using the feedback information known in the communication terminal apparatus, corrects a received signal on a communication channel based on the phase correcting value, or corrects a channel estimation value based on the phase correcting value, and thereby exhibits excellent reception performance.

Brief Description of Drawings

FIG.1 is a diagram to explain transmission diversity;

FIG.2 is a diagram illustrating phases of transmission signals in a base station in common pilot channel signal before phase rotation control is performed;

FIG.3 is a diagram illustrating phases of received signals in a mobile station in the common pilot channel signal before the phase rotation control is performed;

FIG.4 is a diagram illustrating phases of transmission signals in the base station in communication channel signal before the phase rotation control is performed;

FIG.5 is a diagram illustrating phases of received signals in the mobile station in the communication channel signal before the phase rotation control is performed;

FIG.6 is a diagram illustrating phases of transmission signals in the base station in the communication channel signal after the phase rotation control is performed;

FIG.7 is a diagram illustrating phases of received signals in the mobile station in the communication channel signal after the phase rotation control is performed;

FIG.8 is a diagram illustrating phases of received signals in the mobile station in the common pilot channel signal after the phase rotation control is performed;

FIG.9 is a block diagram illustrating a configuration of a communication terminal apparatus according to a first embodiment of the present invention;

FIG.10 is a block diagram illustrating a configuration of a communication terminal apparatus according to a second embodiment of the present invention;

FIG.11 is a block diagram illustrating a configuration of a phase correcting amount calculating section in the communication terminal apparatus according to the above second embodiment;

FIG.12 is a block diagram illustrating a configuration of a communication terminal apparatus according to a third embodiment of the present invention; and

FIG.13 is a diagram to explain coherent detection in the communication terminal apparatus according to this embodiment.

Best Mode for Carrying Out the Invention

Embodiments of the present invention will be described specifically below with reference to accompanying drawings.

(First embodiment)

FIG.9 is a block diagram illustrating a configuration of a communication terminal apparatus according to the first embodiment of the present invention. A signal received at antenna 101 is output to radio reception section 102. Radio reception section 102 performs predetermined radio reception processing (such as downconverting and A/D conversion) on the received signal.

A communication channel signal is subjected to the radio reception processing, and is output to

communication channel despreading section 103 to be despread with a spreading code #0 used in spreading in a base station apparatus. The signal subjected to despreading (despread signal) is output to coherent detection section 104 and channel estimating section 105.

Channel estimating section 105 performs channel estimation using the despread signal to obtain a channel estimation value. The channel estimation value is subjected to phase correction using a phase correcting value obtained as described later, and the phase-corrected channel estimation value is output to coherent detection section 104. Coherent detection section 105 performs coherent detection on the despread signal according to the phase-corrected channel estimation value, and obtains received data.

Meanwhile, a common pilot channel signal is subjected to the radio reception processing in radio reception section 102, and is output to BS antenna 1PL despreading section 106 and BS antenna 2PL despreading section 107. Each of BS antenna 1PL despreading section 106 and BS antenna 2PL despreading section 107 despreads the radio-reception processed signal using a respective spreading code used in spreading in the base station apparatus to obtain a desired despread signals. Specifically, BS antenna 1PL despreading section 106 performs the despreading using a spreading code #1, and acquires a signal transmitted from antenna 1 of the base

station apparatus, while BS antenna 2PL despreading section 107 performs the despreading using a spreading code #2, and acquires a signal transmitted from antenna 2 of the base station apparatus.

The despread signal in BS antenna 1PL despreading section 106 is output to channel estimating section 108. Channel estimating section 108 performs channel estimation on the signal transmitted from antenna 1 of the base station apparatus. The despread signal in BS antenna 2PL despreading section 107 is output to channel estimating section 109. Channel estimating section 109 performs channel estimation on the signal transmitted from antenna 2 of the base station apparatus.

The channel estimation values obtained in channel estimating sections 108 and 109 are output to feedback information calculating section 110. Feedback information calculating section 110 calculates feedback information based on the respective channel estimation values on the signals transmitted from antennas 1 and 2 of the base station apparatus. The feedback information is output to frame composing section 115 on a transmitter side to be notified to the base station apparatus, while being output to storing section 111 to be stored.

Phase correcting amount calculating section 112 acquires the feedback information stored in storing section 111, and calculates a phase correcting amount

with respect to a phase provided on a base station apparatus side in the closed-loop transmission diversity. The phase correcting amount is multiplied in multiplier 113 by the channel estimation value obtained from the communication channel signal previously mentioned. A channel estimation value is thereby obtained with the phase rotation canceled that is provided on the base station apparatus side in the closed-loop transmission diversity. The channel estimation value with the phase rotation canceled is output to coherent detection section 104.

On the transmitter side, transmission data is output to modulating section 114 to be digital-modulated therein. The modulated transmission data is output to frame composing section 115. Frame composing section 115 performs frame composition using the modulated transmission data and the feedback information obtained from the channel estimation value on the common pilot channel signal. The frame-composed transmission data and feedback information is output to radio transmission section 116 to be subjected to predetermined radio transmission processing (such as D/A conversion and upconverting), and is transmitted to the base station apparatus through the antenna.

The operation of the communication terminal apparatus according to this embodiment will be described below. In addition, a case is explained that the

closed-loop transmission diversity is of mode 2.

As illustrated in FIG.2, when common pilot channel signals with the same amplitude and same phase (phase=0) are transmitted respectively from antennas 1 and 2 of the base station, the mobile station receives signals as illustrated in FIG.3. The thus received signal is despread in BS antenna 1PL despreading section 106 with the spreading code #1, and the despread signal is output to channel estimating section 108. Channel estimating section 108 performs the channel estimation on the common pilot channel signal transmitted from antenna 1 of the base station apparatus. The received signal is also despread in BS antenna 2PL despreading section 107 with the spreading code #2, and the despread signal is output to channel estimating section 109. Channel estimating section 109 performs the channel estimation on the common pilot channel signal transmitted from antenna 2 of the base station apparatus.

Respective channel estimation values obtained in channel estimating sections 108 and 109 are output to feedback information calculating section 110. Feedback information calculating section 110 calculates the feedback information using two channel estimation values as described below.

The communication channel signal with the amplitude and phase (phase=0) illustrated in FIG.4 transmitted from the base station apparatus is received as illustrated

in FIG.5. Communication channel signals transmitted from antennas 1 and 2 are combined and received as a signal indicated by a bold arrow as illustrated in FIG.5. At this point, the phase of the combined vector is Φbefore. Φbefore is stored in storing section 111. In FIG.5, A is indicative of the amplitude variation due to fading provided on the transmission signal from antenna 1, while B is indicative of the amplitude variation due to fading provided on the transmission signal from antenna 2.

As can be seen from FIG.3, since a phase rotation difference $\beta - \alpha$ due to fading is about 90° between signals transmitted from antennas 1 and 2, it is expected that rotating the phase of the signal from antenna 2 by -90° increases the combined vector composed of the signals transmitted antennas 1 and 2.

In the mode 2 of the closed-loop transmission diversity, since there are 4 kinds of phase differences, i.e., 0°, +90°, 180° and -90°, which are provided intentionally on a base station apparatus side, the phase of a signal from antenna 2 is set to -90°. The feedback information is thus calculated.

The communication terminal apparatus notifies the base station apparatus of the feedback information (phase difference) calculated in feedback information calculating section 110. Specifically, since the phase differences of the feedback information are of 4 kinds and each is indicated by 2 bits, the feedback information

composed of 2 bits is output to frame composing section 115, and frame composing section 115 composes a frame with the information and transmission data. The feedback information in the frame-composed transmission signal is notified to the base station apparatus.

When the base station apparatus receives the received signal and acquires the feedback information, the apparatus transmits on a next slot a communication channel signal provided with a phase difference corresponding to the feedback information to the communication terminal apparatus. That is, as illustrated in FIG.5, the signal with a phase of -90° is transmitted from antenna 2.

The communication terminal apparatus receives signals as illustrated in FIG.7. At this point, the phase of the combined vector is Φafter. Φafter is obtained in phase correcting amount calculating section 112 as described below. FIG.8 illustrates phases of received common pilot channel signals transmitted from the base station apparatus with the phase rotation provided according to the feedback information. In FIG.8, α' is indicative of the phase rotation due to fading provided on the transmission signal from antenna 1, β' is indicative of the phase rotation due to fading provided on the transmission signal from antenna 2, A′ is indicative of the amplitude variation due to fading provided on the transmission signal from antenna 1, and B′ is indicative

of the amplitude variation due to fading provided on the transmission signal from antenna 2.

Accordingly, Φ after is calculated using these values in the equation that Φ after=tan-1(A'cos α'+B'cos(β'-90°)/ A'sinα'+B'sin(β-90°).

The phase rotation amount by the phase addition in the closed-loop transmission diversity is obtained from a difference between Φ before and Φ after. Accordingly, phase correcting amount calculating section 112 first obtains Φ after, then obtains the difference between Φ before and Φ after using Φ before stored in storing section 111, and thereby obtains the phase correcting amount.

Channel estimating section 105 of the communication terminal apparatus performs channel estimation on a communication channel signal with a phase rotation provided by the closed-loop transmission diversity transmitted from a base station apparatus. The channel estimation value obtained in channel estimating section 105 is multiplied by the phase correcting amount described previously in multiplier 113. The channel estimation value is thereby obtained that is corrected in the phase rotation provided by the closed-loop transmission diversity. The corrected channel estimation value is output to coherent detection section 104. Coherent detection section 104 performs coherent detection on the communication channel signal using the corrected channel estimation value.

It may be possible to provide channel estimating section 105 with a processing section for averaging channel estimation values over a plurality of slots. For example, as illustrated in FIG.13, phase-corrected channel estimation values corresponding to three slots (N-1, N and N+1) of quadrature component (Q channel) are weighted to be averaged, a channel estimation value ξ N on the slot N is thereby obtained, and data of in-phase component (I channel) is subjected to coherent detection using ξ N. It is thereby possible to improve the channel estimating accuracy on a communication channel, and to perform more accurate channel estimation even when the closed-loop transmission diversity is applied.

In this coherent detection, since the channel estimation value is used in which only fading variation is reflected, the channel estimation is capable of being performed by averaging channel estimation values on a plurality of slots to perform the channel estimation. As a result, excellent reception performance is obtained even in the closed-loop transmission diversity.

Thus, the communication terminal apparatus according to this embodiment, in the closed-loop transmission diversity, calculates a correcting value for compensating for an effect of the phase ration in the closed-loop transmission diversity using feedback information that is known on a side of the communication terminal apparatus, corrects a received signal on a

communication channel based on the correcting value, and thereby is capable of performing accurate channel estimation and exhibiting excellent reception performance.

In addition, in this embodiment, the channel estimation value of a communication channel signal is multiplied by the phase correcting value so as to compensate for an effect of the phase rotation in the closed-loop transmission diversity. However, it may be also possible in this embodiment to multiply a communication channel signal by the phase correcting value so as to compensate for an effect of the phase rotation in the closed-loop transmission diversity, and then to perform channel estimation on the compensated communication channel signal. In addition, in order to decrease the number of multiplying calculations (to one time), it is preferable to multiply the channel estimation value by the phase correcting value.

(Second embodiment)

It is considered in the first embodiment that when incorrect feedback information arrives at a base station apparatus, a communication terminal apparatus may perform correction that is not necessary. Therefore, in this embodiment, a case will be described that coherent detection is performed on both communication channel signals which are subjected and not subjected to correction, and that one with a higher communication

quality is used as a coherent detection result. In addition, a case is explained that as a criterion for evaluating the communication quality, SIR (Signal to Interference Ratio) is used.

FIG.10 is a block diagram illustrating a configuration of a communication terminal apparatus according to the second embodiment of the present invention. In FIG.10, the same sections as in FIG.9 are assigned the same reference numerals as in FIG.9, and detailed explanation thereof are omitted.

The communication terminal apparatus illustrated in FIG.10 has multiplier 201 that multiplies a despread signal from communication channel despreading section 103 by a phase correcting value calculated in phase correcting amount calculating section 112, SIR comparing section 203 which measures SIR on a coherent detection result of a despread signal subjected to phase correction and SIR on another coherent detection result obtained by performing coherent detection on the despread signal without performing the phase correction and which compares both measured results with each other, and selecting section 202 that selects one of the coherent detection results based on the compared result of SIR.

In the communication terminal apparatus with such a configuration, coherent detection section 104 performs coherent detection on a despread signal from communication channel despreading section 103, and

outputs the coherent detection result to SIR comparing section 203. Meanwhile, multiplier 201 multiplies the despread signal from communication channel despreading section 103 by the phase correcting value calculated in phase correcting amount calculating section 112. In addition, the phase correcting value is calculated in the same as in the first embodiment. The phase-corrected despread signal (communication channel signal) is output to coherent detection section 104. Coherent detection section 104 performs the coherent detection on the phase-corrected despread signal, and outputs the coherent detection result to SIR comparing section 203.

SIR comparing section 203 measures SIR on the two coherent detection results, and compares the measured results. The compared result is output to selecting section 202. Selecting section 202 receives as its inputs the two coherent detection results from coherent detection section 104, and based on the compared result from SIR comparing section 203, selects one coherent detection result with an excellent communication quality.

In this case, the coherent detection on the phase-corrected despread signal is selected when the phase correction should be performed, while the coherent detection result on the despread signal that is not subjected to the phase correction is selected when the phase correction should not be performed.

Further in this embodiment, it may be possible to

configure phase correcting amount calculating section 112 as illustrated in FIG.11. The following operation is performed in this configuration. Since a communication terminal apparatus stores the feedback information, the terminal apparatus knows a phase of a signal transmitted from a base station apparatus. Accordingly, the terminal apparatus calculates a candidate of a phase of a signal that is expected to receive when the signal of each phase (for example, 0°, +90°, -90° and 180°) is transmitted. Specifically, received phase candidate calculating section 204 acquires feedback information stored in storing section 111, and based on the feedback information, calculates received phase candidates.

The received phase candidates are output to comparing section 205. Comparing section 205 compares each of the received phase candidates with an actual phase of a received signal obtained from the despread signal, and outputs compared results to judging section 206. Judging section 206 selects a received phase candidate with the smallest angle difference between the compared results. Selecting the received phase candidate is equivalent to judging that a signal with the phase is transmitted from the base station apparatus. The judged result is output to correcting value calculating section 207. Based on the judged phase, correcting value calculating section 207 calculates a phase correcting

amount.

Thus, by configuring phase correcting amount calculating section 112 in the way described above, even when a base station apparatus receives incorrect feedback information, it is possible to perform accurate channel estimation and to exhibit excellent reception performance.

In the above-mentioned embodiment, the case is explained that a communication terminal apparatus calculates a phase correcting value using the feedback information to be transmitted to a base station apparatus. However, the present invention is capable of being applied to a case that a communication terminal apparatus does not use the feedback information to be transmitted to a base station apparatus.

For example, since all n types of phase rotation amounts (for example, 0°, 90°, 180° and -90°) are predetermined that have a possibility of being provided by a base station apparatus in the closed-loop transmission diversity, a communication terminal apparatus is capable of calculating a phase predict value of a received communication channel signal transmitted with each phase rotation amount provided. Each phase predict value is compared with a phase of a channel estimation value obtained from a received communication channel signal, and each angle difference is obtained. These angle differences are used as likelihood. In other

words, a phase rotation amount with the highest likelihood (smallest angle difference) is selected from among n types of them. The phase correcting value is calculated based on the selected phase rotation amount.

The need for communicating the feedback information with a base station apparatus is thereby eliminated, whereby it is possible to simplify the communication control and also to improve the transmission efficiency.

When a communication terminal apparatus thus compares a phase predict value with a phase of a channel estimation value to select a phase rotation amount, the terminal apparatus uses the feedback information to be transmitted to a base station apparatus. When the communication terminal apparatus transmits the feedback information to the base station apparatus, a case may occur that the base station apparatus receives erroneous feedback information. In this case, by using both the phase rotation amount obtained by using the phase predict value as described above and the feedback information, the communication terminal apparatus is capable of identifying the phase rotation amount provided by the base station apparatus with high accuracy.

When the feedback information is composed of a plurality of bits, a probability that erroneous information is transmitted is not the same on all the phase rotation amounts. For example, the probability that 2 bits are erroneous is lower than the probability

that 1 bit is erroneous. Therefore the probability that a base station apparatus transmits signals according to the feedback information with two erroneous bits is lower than the probability that the base station apparatus transmits signals according to the feedback information with one erroneous bit.

For example, when the feedback information is transmitted with bits 00 indicative of 0°, bits 01 indicative of 90°, bits 01 indicative of 180°, and bits 11 indicative of -90° and the communication terminal apparatus transmits bits 00, the probability that the base station apparatus receives bits 11 incorrectly is lower than the probability that the base station apparatus receives bits 01 or 10 incorrectly. Accordingly, when the communication terminal apparatus transmits bits 00, it is more likely for the base station apparatus to receive the bits as 90° or 180° than as -90°. Then the likelihood calculated with 90° or 180° is more weighted than the likelihood calculated with -90°. It is thereby possible to improve the accuracy in judging the phase rotation with which the base station apparatus provides a signal in transmitting.

Thus, according to the present invention, coherent detection is performed on both communication channel signals which are subjected and not subjected to phase correction, and one with an excellent communication quality is used as a coherent detection result, whereby

even when incorrect feedback information arrives at a base station apparatus, it is possible to perform accurate channel estimation and to exhibit excellent reception performance. The present invention thereby enables excellent reception performance with higher accuracy in the closed-loop transmission diversity.

(Third embodiment)

As phase rotation amounts in the closed-loop transmission diversity, angles (0°, +90°, 180° and -90°) are predetermined. In this embodiment, a case is explained that a communication terminal apparatus calculates correcting values always corresponding to all the phase rotation amounts, performs the coherent detection while performing the phase correction, and adopts, as the coherent detection result, one with an excellent communication quality among the coherent detection results. In addition, a case is explained that as a criterion for evaluating the communication quality, SIR (Signal to Interference Ratio) is used.

FIG.12 is a block diagram illustrating a configuration of a communication terminal apparatus according to the third embodiment of the present invention. In FIG.12, the same sections as in FIG.9 are assigned the same reference numerals as in FIG.9, and detailed explanation thereof are omitted.

The communication terminal apparatus illustrated in FIG.12 has a plurality of multipliers 403 each of which

multiplies a despread signal from communication channel despreading section 103 by a phase correcting value calculated in phase correcting amount calculating section 402 using phase rotation information table 401, SIR comparing section 404 which measures SIR on each coherent detection result of the despread signal subjected to phase correction and which compares the measured results with each other, and selecting section 405 that selects one of the coherent detection results based on the compared result of SIR.

In the communication terminal apparatus with such a configuration, the phase rotation amounts which are predetermined in the closed-loop transmission diversity are stored in phase rotation information table 401. Phase correcting amount calculating section 402 refers to the phase rotation amounts in phase rotation amount information table 401 to calculate phase correcting values. In addition, the phase correcting values are calculated in the same way as in the first embodiment.

Each of multipliers 403 multiplies the despread signal from communication channel despreading section 103 by a respective phase correcting value calculated in phase correcting amount calculating section 402. At this point, multipliers 403 multiply the despread signal respectively by the phase correcting values corresponding to all the phase rotation amounts predetermined in the closed-loop transmission diversity. Then, the

phase-corrected despread signals (communication channel signals) are output to coherent detection section 104. Coherent detection section 104 performs coherent detection on each phase-corrected despread signal, and outputs the coherent detection result to SIR comparing section 404.

SIR comparing section 404 measures respective SIR on all the coherent detection results, and compares the measured results. The compared result is output to selecting section 405. Selecting section 405 receives as its inputs all the coherent detection results from coherent detection section 104, and based on the compared result from SIR comparing section 404, selects one coherent detection result with an excellent communication quality.

Thus, according to this embodiment, the coherent detection is performed with all the phase correcting values corresponding to all the phase rotation amounts predetermined in the closed-loop transmission diversity, and one with an excellent communication quality is adopted as the coherent detection result, whereby it is not necessary for a communication terminal apparatus to store the feedback information. Since the need for storing information is thereby eliminated in the closed-loop transmission diversity, it is possible to use a memory in a communication terminal apparatus effectively.

The present invention is not limited to the

above-mentioned first to third embodiments, and is capable of being carried into practice with various modifications thereof. For example, in the above-mentioned first to third embodiments is explained the case that the closed-loop transmission diversity is of mode 2. However, the present invention is capable of being applied to closed-loop transmission diversity of another mode. In the above-mentioned second and third embodiments is explained the case that SIR is used as a criterion for evaluating a communication quality to judge whether phase correction is needed. However, the present invention is capable of being applied to another case that as a criterion for evaluating a communication quality, another criterion other than SIR, such as likelihood, is used.

A communication terminal apparatus of the present invention has a configuration provided with a feedback information calculating section that calculates feedback information using respective first channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity, a phase correcting amount calculating section that calculates a phase correcting amount for correcting phase rotation with which the base station apparatus provides a communication channel signal in the transmission diversity, based on the feedback information,

and a coherent detection section that performs coherent detection on the communication channel signal using a second channel estimation value obtained by subjecting a channel estimation value obtained from the communication channel signal to phase correction using the phase correcting amount.

A communication terminal apparatus of the present invention has a configuration provided with a feedback information calculating section that calculates feedback information using respective first channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity, a phase correcting amount calculating section that calculates a phase correcting amount for correcting phase rotation with which the base station apparatus provides a communication channel signal in the transmission diversity, based on the feedback information, a channel estimating section that performs channel estimation using the communication channel signal subjected to phase correction using the phase correcting amount, and a coherent detection section that performs coherent detection on the communication channel signal using a second channel estimation value obtained by the channel estimation.

According to these configurations, in the closed-loop transmission diversity, the communication

terminal apparatus calculates the correcting value for compensating for an effect of the phase rotation due to the transmission diversity using the known feedback information, corrects a received signal on the communication channel based on the correcting value, and thereby is capable of performing accurate channel estimation and of exhibiting excellent reception performance.

The communication terminal apparatus of the present invention has the above-described configuration further provided with a weighting averaging section that performs weighting on second channel estimation values over a plurality of slots to average, and performs the coherent detection on an average of weighted channel estimation values.

According to this configuration, it is possible to improve channel estimation accuracy on the communication channel. It is thereby possible to perform accurate channel estimation even when the closed-loop transmission diversity is applied.

A communication terminal apparatus of the present invention has a configuration provided with a feedback information calculating section that calculates feedback information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity, a

phase correcting amount calculating section that calculates a phase correcting amount for correcting phase rotation with which the base station apparatus provides a communication channel signal in the transmission diversity, based on the feedback information, a communication quality measuring section that measures communication qualities of the communication channel signal subjected to coherent detection and of the communication channel signal subjected to phase correction using the phase correcting amount and to coherent detection, and a selecting section that selects one with an excellent measured communication quality from the communication channel signals.

According to this configuration, the communication terminal apparatus performs coherent detection on both communication channel signals which are subjected and not subjected to phase correction, uses one with an excellent communication quality as a coherent detection result, and therefore is, even when incorrect feedback information arrives at a base station apparatus, capable of performing accurate channel estimation and of exhibiting excellent reception performance. The communication terminal apparatus is thereby capable of exhibiting excellent reception performance with higher accuracy in the closed-loop transmission diversity.

A communication terminal apparatus of the present invention has a configuration provided with a phase

correcting amount calculating section that calculates a plurality of phase correcting amounts each for correcting phase rotation with which a base station apparatus provides a communication channel signal in closed-loop transmission diversity, based on the phase rotation amounts in the closed-loop transmission diversity, a communication quality measuring section that measures communication qualities of communication channel signals obtained by subjecting the communication channel signal transmitted from the base station apparatus to phase correction using the plurality of phase correcting amounts and to coherent detection, and a selecting section that selects one with an excellent measured communication quality from the communication channel signals.

According to this configuration, the coherent detection is performed with all the phase correcting values corresponding to all the phase rotation amounts predetermined in the closed-loop transmission diversity, and one with an excellent communication quality is adopted as the coherent detection result, whereby it is not necessary for a communication terminal apparatus to store the feedback information. Since the need for storing information is thus eliminated in the closed-loop transmission diversity, it is possible to use a memory in a communication terminal apparatus effectively.

A communication terminal apparatus of the present

invention has a configuration provided with a phase predict value calculating section that obtains a respective phase predict value in receiving a communication channel signal provided with each phase rotation, for each phase rotation amount defined in closed-loop transmission diversity, a channel estimating section that obtains a channel estimation value from a received communication channel signal, and a phase correcting amount calculating section which obtains a respective angle difference between a phase of the channel estimation value and each phase predict value, and based on the phase predict value corresponding to the angle difference with highest likelihood among the angle differences, which calculates a phase correcting amount.

According to this configuration, the need for communicating the feedback information with a base station apparatus is eliminated, whereby it is possible to simplify the communication control and also to improve the transmission efficiency.

The communication terminal apparatus of the present invention performs, in the above-mentioned configuration, weighting on likelihood corresponding to feedback information to be transmitted to a base station apparatus. According to this configuration, the communication terminal apparatus is capable of identifying the phase rotation amount provided by the base station apparatus with high accuracy.

A base station apparatus of the present invention has a feature of performing radio communications with the communication terminal apparatus with the above-mentioned configuration. It is thereby possible to perform the radio communications while maintaining excellent reception performance even in the closed-loop transmission diversity.

In a radio communication method of the present invention, in closed-loop transmission diversity, a communication terminal apparatus calculates feedback information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus, and transmits the feedback information to the base station apparatus, the base station apparatus transmits a communication channel signal provided with phase rotation based on the feedback information to the communication terminal apparatus, and the communication terminal apparatus calculates a phase correcting amount for correcting the phase rotation based on the feedback information, and performs coherent detection on the communication channel signal using a channel estimation value subjected to phase correction using the phase correcting amount.

In a radio communication method of the present invention, in closed-loop transmission diversity, a communication terminal apparatus calculates feedback

information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus, and transmits the feedback information to the base station apparatus, the base station apparatus transmits a communication channel signal provided with phase rotation based on the feedback information to the communication terminal apparatus, and the communication terminal apparatus calculates a phase correcting amount for correcting the phase rotation based on the feedback information, performs channel estimation using the communication channel signal subjected to phase correction using the phase correcting amount and performs coherent detection on the communication channel signal using a channel estimation value obtained by the channel estimation.

According to these methods, in the closed-loop transmission diversity, the communication terminal apparatus calculates the correcting value for compensating for an effect of the phase rotation due to the transmission diversity using the known feedback information, corrects a received signal on the communication channel based on the correcting value, and thereby is capable of performing accurate channel estimation and of exhibiting excellent reception performance.

In a radio communication method of the present

invention, in closed-loop transmission diversity, a communication terminal apparatus calculates feedback information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus, and transmits the feedback information to the base station apparatus, the base station apparatus transmits a communication channel signal provided with phase rotation based on the feedback information to the communication terminal apparatus, and the communication terminal apparatus calculates a phase correcting amount for correcting the phase rotation based on the feedback information, measures communication qualities of the communication channel signal subjected to coherent detection and of the communication channel signal subjected to phase correction using the phase correcting amount and to coherent detection, and selects one with an excellent measured communication quality from the communication channel signals.

According to this method, coherent detection is performed on both communication channel signals which are subjected and not subjected to phase correction, and one with an excellent communication quality is used as a coherent detection result, whereby even when incorrect feedback information arrives at a base station apparatus, it is possible to perform accurate channel estimation and to exhibit excellent reception performance. The

present invention thereby enables excellent reception performance with higher accuracy in the closed-loop transmission diversity.

In a radio communication method of the present invention, in closed-loop transmission diversity, a communication terminal apparatus calculates feedback information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus, and transmits the feedback information to the base station apparatus, the base station apparatus transmits a communication channel signal provided with phase rotation based on the feedback information to the communication terminal apparatus, and the communication terminal apparatus calculates a plurality of phase correcting amounts each for correcting the phase rotation based on the feedback information, measures communication qualities of communication channel signals obtained by subjecting the communication channel signal transmitted from the base station apparatus to phase correction using the plurality of phase correcting amounts and to coherent detection, and selects one with an excellent measured communication quality from the communication channel signals.

According to this method, the coherent detection is performed with all the phase correcting values corresponding to all the phase rotation amounts

predetermined in the closed-loop transmission diversity, and one with an excellent communication quality is adopted as the coherent detection result, whereby it is not necessary for a communication terminal apparatus to store the feedback information. Since the need for storing information is thus eliminated in the closed-loop transmission diversity, it is possible to use a memory in the communication terminal apparatus effectively.

According to the present invention as described above, in the closed-loop transmission diversity, a communication terminal apparatus calculates the correcting value for compensating for an effect of the phase rotation due to the transmission diversity using the known feedback information, corrects a received signal on the communication channel based on the correcting value, and thereby is capable of performing accurate channel estimation and of exhibiting excellent reception performance.

This application is based on the Japanese Patent Application No.HEI11-346468 filed on December 6, 1999, entire content of which is expressly incorporated by reference herein.

Industrial Applicability

The present invention is applicable to a digital radio communication system, and more particularly to a communication terminal apparatus and radio communication

method in a DS-CDMA system.

CLAIMS

1. A communication terminal apparatus comprising:

feedback information calculating means for calculating feedback information using respective first channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity;

phase correcting amount calculating means for calculating a phase correcting amount for correcting phase rotation with which said base station apparatus provides a communication channel signal in said transmission diversity, based on the feedback information; and

coherent detection means for performing coherent detection on the communication channel signal using a second channel estimation value obtained by subjecting a channel estimation value obtained from the communication channel signal to phase correction using the phase correcting amount.

2. A communication terminal apparatus comprising:

feedback information calculating means for calculating feedback information using respective first channel estimation values obtained from respective common known signals transmitted respectively from different

antennas of a base station apparatus in closed-loop transmission diversity;

phase correcting amount calculating means for calculating a phase correcting amount for correcting phase rotation with which said base station apparatus provides a communication channel signal in said transmission diversity, based on the feedback information;

channel estimating means for performing channel estimation using the communication channel signal subjected to phase correction using the phase correcting amount; and

coherent detection means for performing coherent detection on the communication channel signal using a second channel estimation value obtained by the channel estimation.

3. The communication terminal apparatus according to claim 1, further comprising:

weighting averaging means for performing weighting on second channel estimation values over a plurality of slots to average,
wherein the coherent detection is performed on an average of weighted channel estimation values.

4. A communication terminal apparatus comprising:

feedback information calculating means for calculating feedback information using respective

channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity;

phase correcting amount calculating means for calculating a phase correcting amount for correcting phase rotation with which said base station apparatus provides a communication channel signal in said closed-loop transmission diversity, based on the feedback information;

communication quality measuring means for measuring communication qualities of the communication channel signal subjected to coherent detection and of the communication channel signal subjected to phase correction using the phase correcting amount and to coherent detection; and

selecting means for selecting one with an excellent measured communication quality from the communication channel signals.

5. A communication terminal apparatus comprising:

phase correcting amount calculating means for calculating a plurality of phase correcting amounts each for correcting phase rotation with which said base station apparatus provides a communication channel signal in said closed-loop transmission diversity, based on phase rotation amounts in said closed-loop transmission

diversity;

communication quality measuring means for measuring communication qualities of communication channel signals obtained by subjecting the communication channel signal transmitted from said base station apparatus to phase correction using the plurality of phase correcting amounts and to coherent detection; and

selecting means for selecting one with an excellent measured communication quality from the communication channel signals.

6. A communication terminal apparatus comprising:

phase predict value calculating means for obtaining a respective phase predict value in receiving a communication channel signal provided with each phase rotation, for each phase rotation amount defined in closed-loop transmission diversity;

channel estimating means for obtaining a channel estimation value from a received communication channel signal; and

phase correcting amount calculating means for obtaining an angle difference between a phase of the channel estimation value and each phase predict value, and based on the phase predict value corresponding to the angle difference with highest likelihood among angle differences, calculating a phase correcting amount.

7. The communication terminal apparatus

according to claim 6, wherein corresponding to feedback information to be transmitted to a base station apparatus, the likelihood is weighted.

8. A base station apparatus that performs radio communications with a communication terminal apparatus, said communication terminal apparatus comprising:

feedback information calculating means for calculating feedback information using respective first channel estimation values obtained from respective common known signals transmitted respectively from different antennas of said base station apparatus in closed-loop transmission diversity;

phase correcting amount calculating means for calculating a phase correcting amount for correcting a phase rotation with which said base station apparatus provides a communication channel signal in said transmission diversity, based on the feedback information; and

coherent detection means for performing coherent detection on the communication channel signal using a second channel estimation value obtained by subjecting a channel estimation value obtained from the communication channel signal to phase correction using the phase correcting amount.

9. A radio communication method, comprising:

calculating, in a communication terminal apparatus, feedback information using respective channel estimation

values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity, and transmitting the feedback information to said base station apparatus;

transmitting, in said base station apparatus, a communication channel signal provided with phase rotation based on the feedback information to said communication terminal apparatus; and

calculating, in said communication terminal apparatus, a phase correcting amount for correcting the phase rotation based on the feedback information, and performing coherent detection on the communication channel signal using a channel estimation value subjected to phase correction using the phase correcting amount.

10. A radio communication method, comprising:

calculating, in a communication terminal apparatus, feedback information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity, and transmitting the feedback information to said base station apparatus;

transmitting, in said base station apparatus, a communication channel signal provided with phase rotation based on the feedback information to said communication terminal apparatus; and

calculating, in said communication terminal apparatus, a phase correcting amount for correcting the phase rotation based on the feedback information, performing channel estimation using the communication channel signal subjected to phase correction using the phase correcting amount, and performing coherent detection on the communication channel signal using a channel estimation value obtained by the channel estimation.

11. A radio communication method, comprising:

calculating, in a communication terminal apparatus, feedback information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity, and transmitting the feedback information to said base station apparatus;

transmitting, in said base station apparatus, a communication channel signal provided with phase rotation based on the feedback information to said communication terminal apparatus; and

calculating, in said communication terminal apparatus, a phase correcting amount for correcting the phase rotation based on the feedback information, measuring communication qualities of the communication channel signal subjected to coherent detection and of the communication channel signal subjected to phase

correction using the phase correcting amount and to coherent detection, and selecting one with an excellent measured communication quality from the communication channel signals.

12. A radio communication method, comprising:

calculating, in a communication terminal apparatus, feedback information using respective channel estimation values obtained from respective common known signals transmitted respectively from different antennas of a base station apparatus in closed-loop transmission diversity, and transmitting the feedback information to said base station apparatus;

transmitting, in said base station apparatus, a communication channel signal provided with phase rotation based on the feedback information to said communication terminal apparatus; and

calculating, in said communication terminal apparatus, a plurality of phase correcting amounts each for correcting the phase rotation with which said base station apparatus provides a communication channel signal in said closed-loop transmission diversity, based on the feedback information, measuring communication qualities of communication channel signals obtained by subjecting the communication channel signal transmitted from said base station apparatus to phase correction using the plurality of phase correcting amounts and to coherent detection, and selecting one with an excellent measured

communication quality from the communication channel signals.

ABSTRACT

In closed-loop transmission diversity, a communication terminal apparatus calculates a phase correcting value for compensating for an effect of phase rotation due to the transmission diversity, using known feedback information, and corrects a received signal on a communication channel based on the phase correcting value, or corrects a channel estimation value based on the phase correcting value.

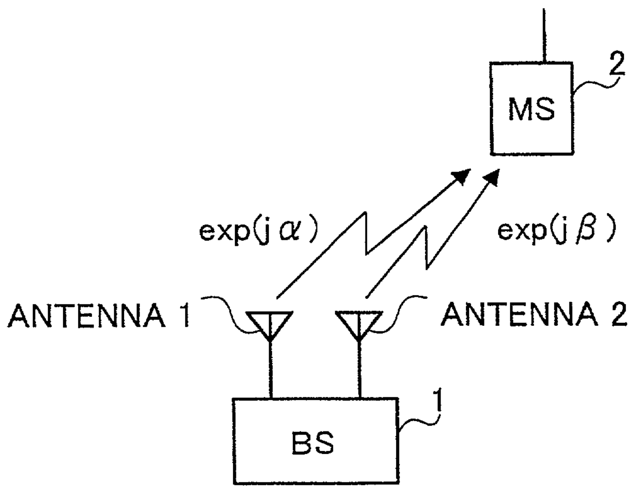


FIG.1

TRANSMISSION SIGNALS IN BASE STATION
IN COMMON PILOT CHANNEL SIGNAL

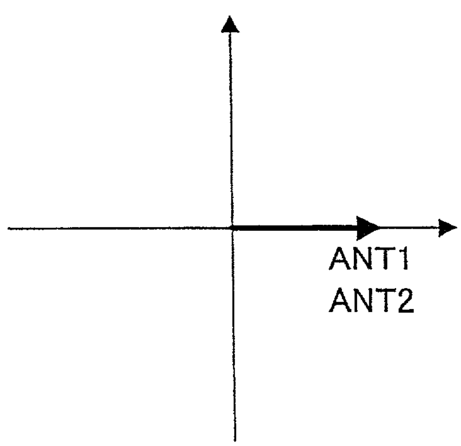


FIG.2

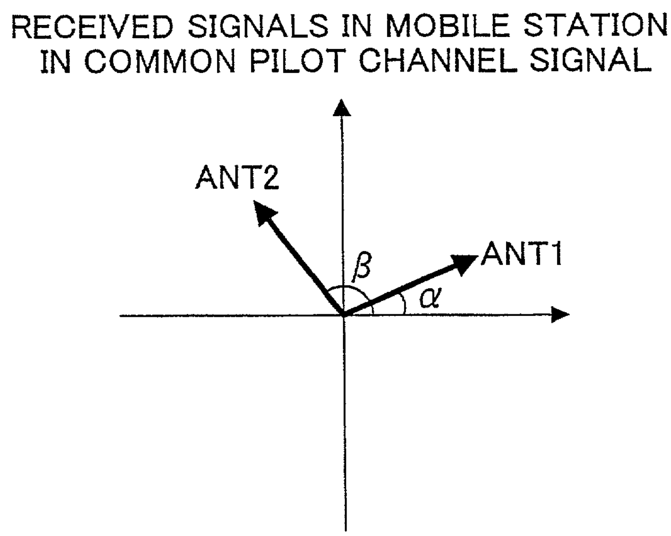

RECEIVED SIGNALS IN MOBILE STATION
IN COMMON PILOT CHANNEL SIGNAL
ANT2
ANT1
β
α

FIG.3

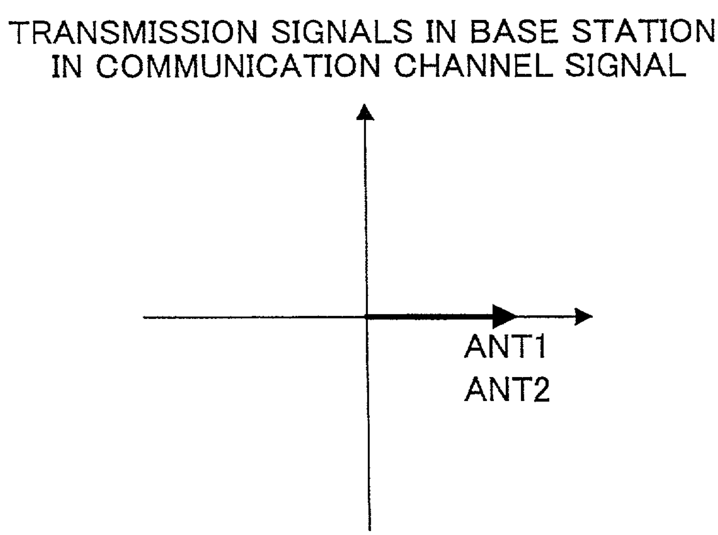

TRANSMISSION SIGNALS IN BASE STATION
IN COMMUNICATION CHANNEL SIGNAL
ANT1
ANT2

FIG.4

RECEIVED SIGNALS IN MOBILE STATION
IN COMMUNICATION CHANNEL SIGNAL

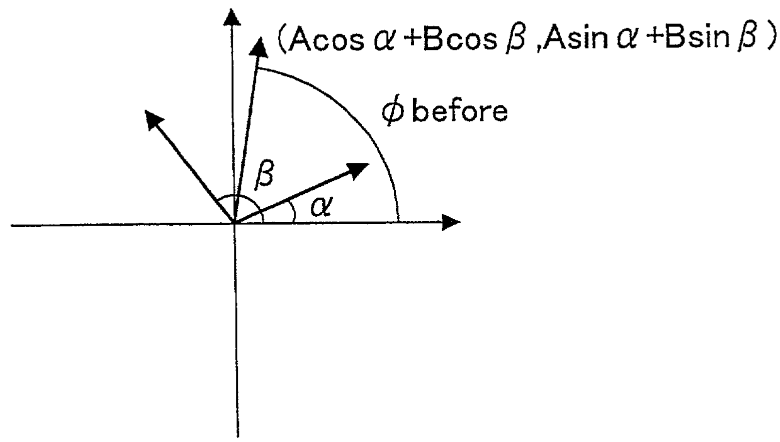


FIG.5

TRANSMISSION SIGNALS IN BASE STATION
IN COMMUNICATION CHANNEL SIGNAL

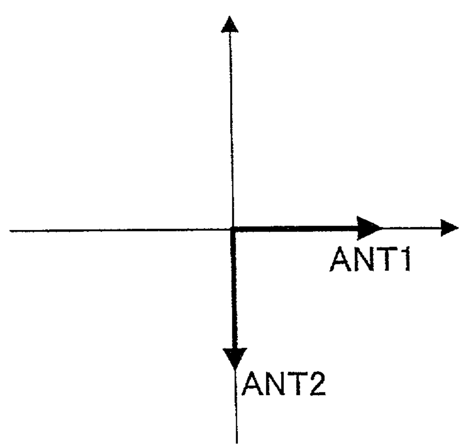


FIG.6

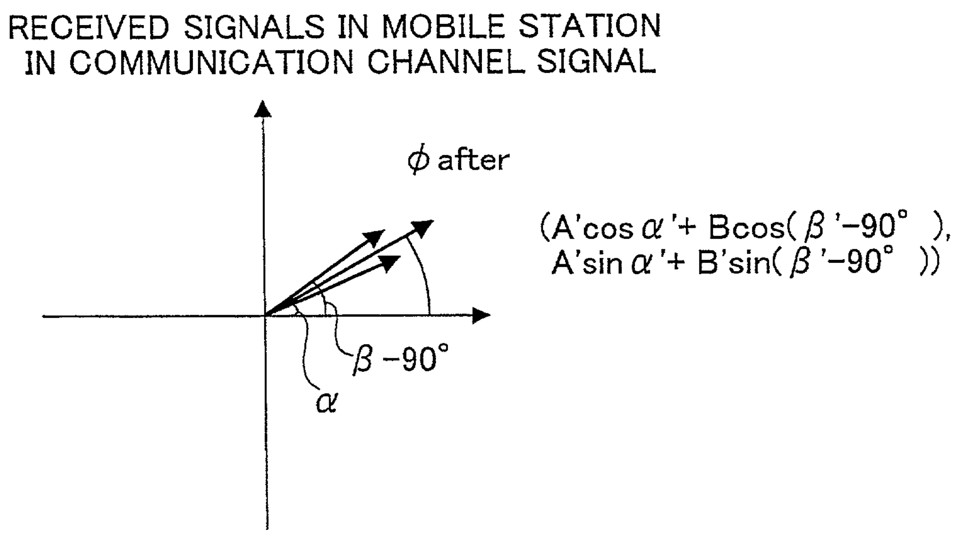

RECEIVED SIGNALS IN MOBILE STATION
IN COMMUNICATION CHANNEL SIGNAL
ϕ after
(A'cos α'+ Bcos(β'−90°),
A'sin α'+ B'sin(β'−90°))
β −90°
α

FIG.7

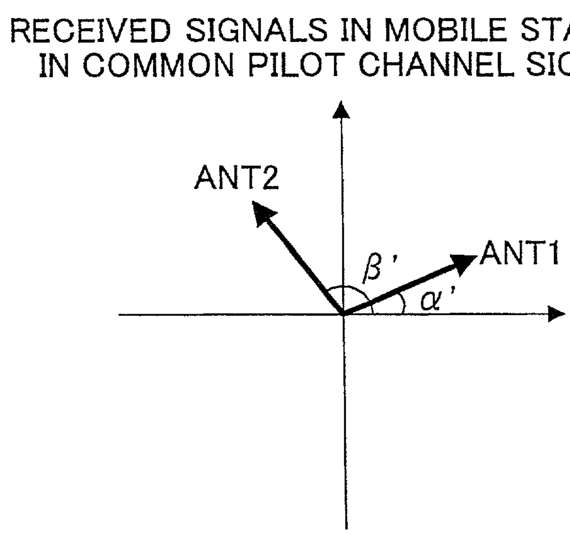

RECEIVED SIGNALS IN MOBILE STATION
IN COMMON PILOT CHANNEL SIGNAL
ANT2
ANT1
β'
α'

FIG.8

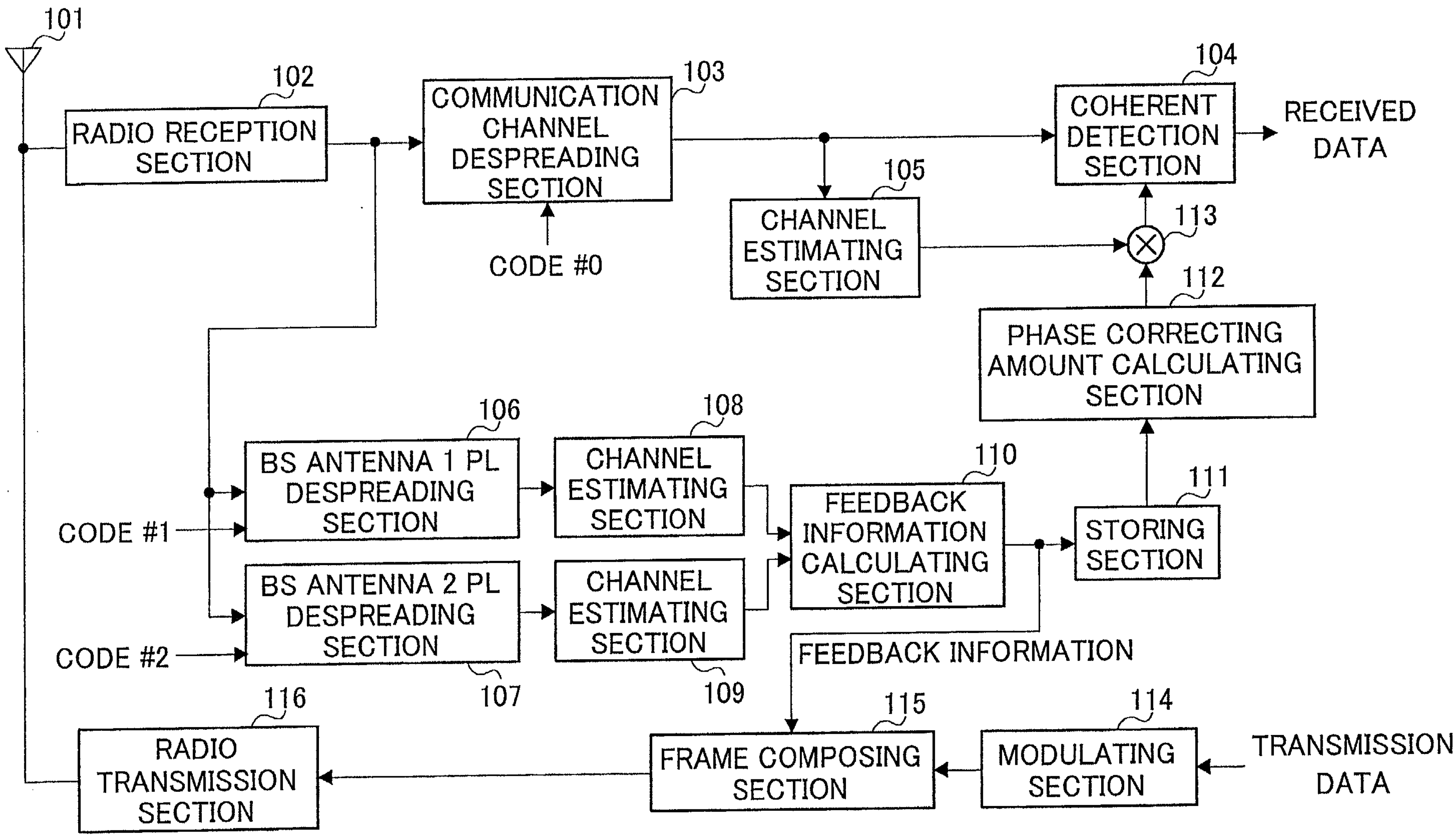

101
102
RADIO RECEPTION SECTION
103
COMMUNICATION CHANNEL DESPREADING SECTION
CODE #0
104
COHERENT DETECTION SECTION
RECEIVED DATA
105
CHANNEL ESTIMATING SECTION
113
112
PHASE CORRECTING AMOUNT CALCULATING SECTION
106
BS ANTENNA 1 PL DESPREADING SECTION
CODE #1
107
BS ANTENNA 2 PL DESPREADING SECTION
CODE #2
108
CHANNEL ESTIMATING SECTION
109
CHANNEL ESTIMATING SECTION
110
FEEDBACK INFORMATION CALCULATING SECTION
111
STORING SECTION
FEEDBACK INFORMATION
114
MODULATING SECTION
TRANSMISSION DATA
115
FRAME COMPOSING SECTION
116
RADIO TRANSMISSION SECTION

FIG.9

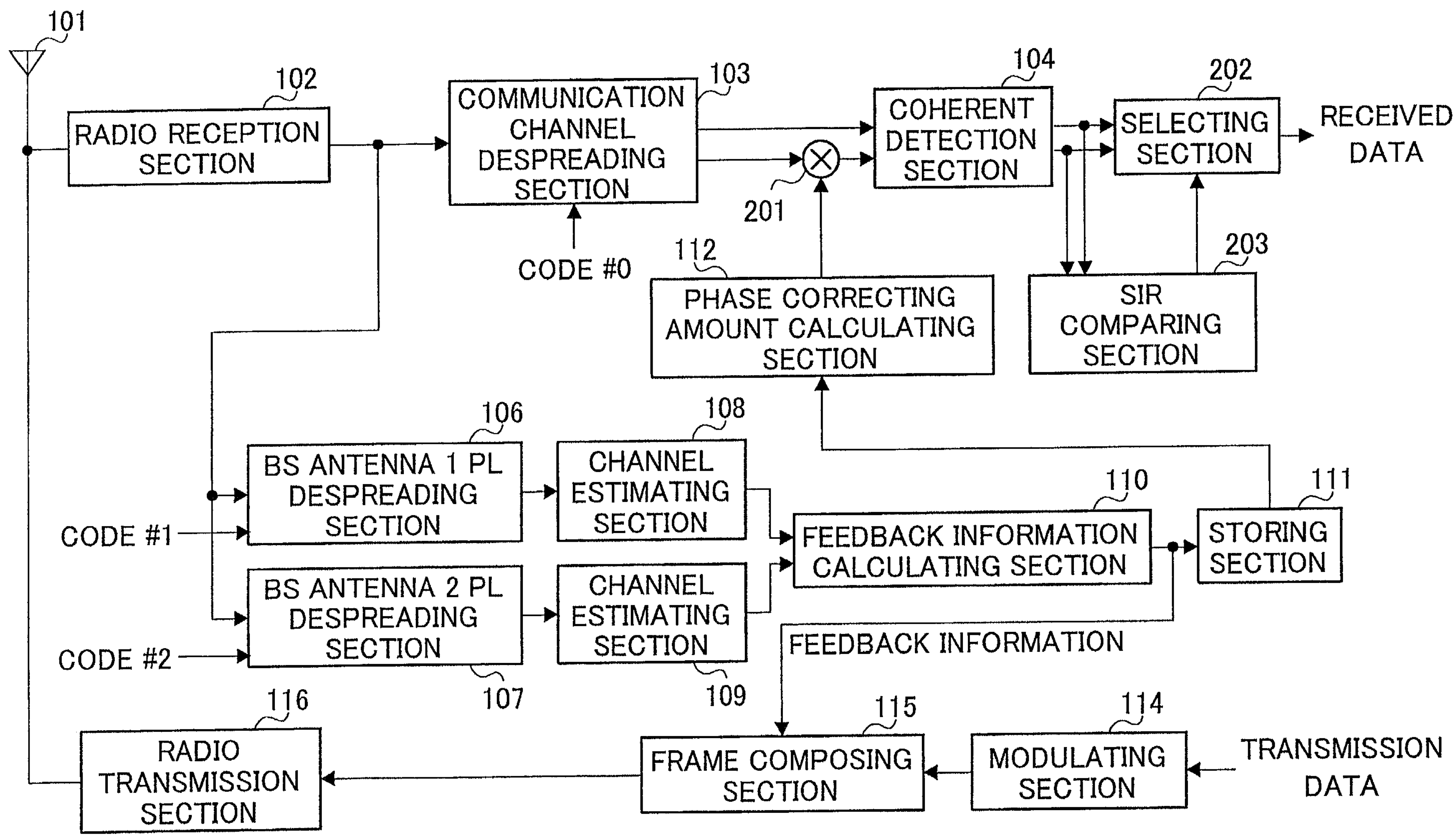

101
102
RADIO RECEPTION SECTION
103
COMMUNICATION CHANNEL DESPREADING SECTION
CODE #0
104
COHERENT DETECTION SECTION
201
202
SELECTING SECTION
RECEIVED DATA
112
PHASE CORRECTING AMOUNT CALCULATING SECTION
203
SIR COMPARING SECTION
106
BS ANTENNA 1 PL DESPREADING SECTION
CODE #1
108
CHANNEL ESTIMATING SECTION
107
BS ANTENNA 2 PL DESPREADING SECTION
CODE #2
109
CHANNEL ESTIMATING SECTION
110
FEEDBACK INFORMATION CALCULATING SECTION
111
STORING SECTION
FEEDBACK INFORMATION
116
RADIO TRANSMISSION SECTION
115
FRAME COMPOSING SECTION
114
MODULATING SECTION
TRANSMISSION DATA

FIG.10

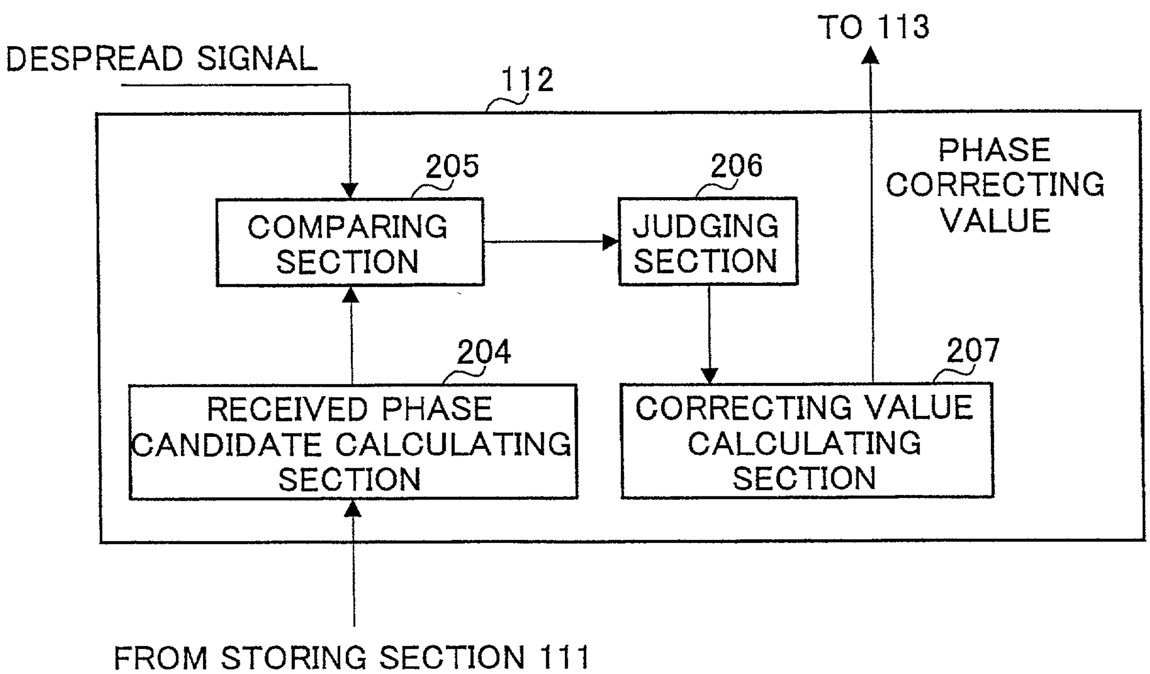
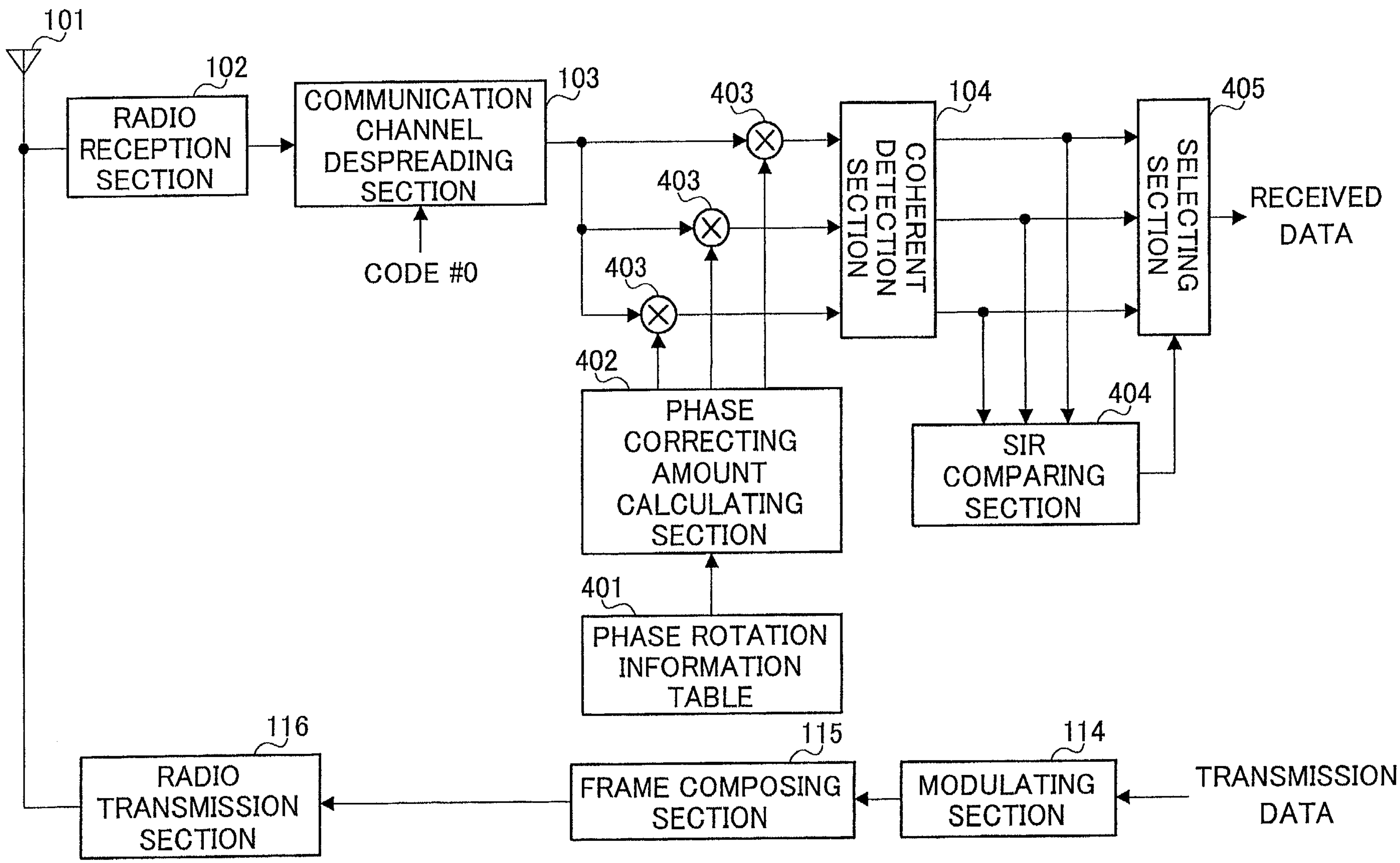

DESPREAD SIGNAL
TO 113
112
205
206
COMPARING SECTION
JUDGING SECTION
PHASE CORRECTING VALUE
204
207
RECEIVED PHASE CANDIDATE CALCULATING SECTION
CORRECTING VALUE CALCULATING SECTION
FROM STORING SECTION 111

FIG.11



101
102
RADIO RECEPTION SECTION
103
COMMUNICATION CHANNEL DESPREADING SECTION
CODE #0
403
403
403
104
COHERENT DETECTION SECTION
405
SELECTING SECTION
RECEIVED DATA
402
PHASE CORRECTING AMOUNT CALCULATING SECTION
404
SIR COMPARING SECTION
401
PHASE ROTATION INFORMATION TABLE
116
RADIO TRANSMISSION SECTION
115
FRAME COMPOSING SECTION
114
MODULATING SECTION
TRANSMISSION DATA

FIG.12

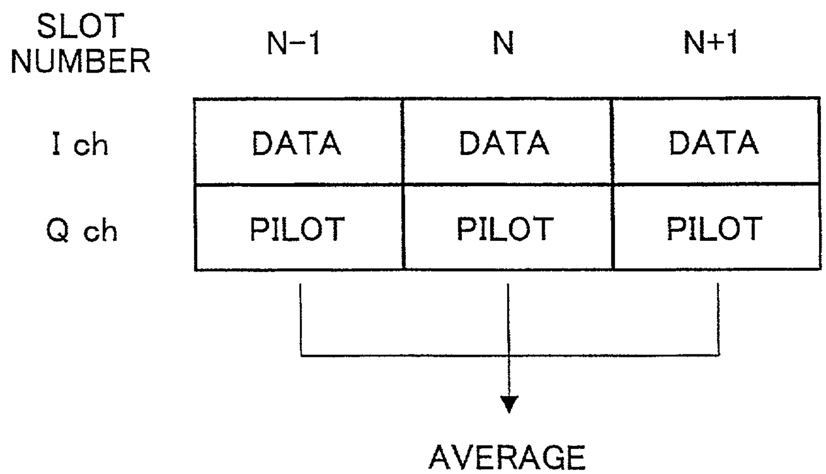

SLOT NUMBER
N-1
N
N+1
I ch
DATA
DATA
DATA
Q ch
PILOT
PILOT
PILOT
AVERAGE

FIG.13

APPLICATION FOR UNITED STATES PATENT
Declaration for Patent Application

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name.
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on

the invention entitled: COMMUNICATION TERMINAL APPARATUS AND RADIO COMMUNICATION METHOD

the specification of which 2 (file no ____________)

(check at least one)
3 [X] is attached hereto
4 [ ] was filed on ____________ as (5) U.S. Application Serial No. ____________
6 [ ] and was amended ____________ (if applicable)

Use this portion only if you are entering the U.S. National phase based on a PCT International Application designating the U.S.		
	7 [x]	was filed as PCT international application
	8	Number PCT/JP00/08151
	9	on November 20, 2000
		and was amended under PCT Article(s) 19 and/or 34
	10	on ____________ (if applicable).

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended, by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application (s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date earlier than that of the application(s) on which priority is claimed.

Prior (Foreign) Application(s) any Priority Claims Under 35 U.S.C. 119 — Priority Claimed

	(Country)	(Number)	(Day/Month/Year Filed)	Yes	No
11a	JAPAN	JP11-346468	6/12/1999	[x]	[ ]
				[ ]	[ ]

[ ] Additional foreign application numbers are listed on a supplemental priority data sheet attached hereto.

Priority Claim(s) from U.S. Provisional Application(s) – I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

11b ____________ ____________ ____________ ____________
Application No. Day/Month/Year Filed Application No. Day/Month/Year Filed

Do not use this portion to identify a PCT application if the parent application is the U.S. National phase of the PCT application	I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between filing date of the prior application and the national or PCT international filing date of this application. 13 ____________ (U.S. Application Number) ____________ (U.S. Filing Date) ____________ Status (patented, pending, abandoned)

I hereby appoint the following attorneys of the firm of Stevens, Davis, Miller & Mosher, L.L.P. as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

2 James E. Ledbetter, Reg. No. 28732; Thomas P. Pavelko, Reg. No. 31689; and Anthony P. Venturino, Reg. No. 31674.

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO STEVENS, DAVIS, MILLER & MOSHER, L.L.P. 1615 L Street, N.W., Suite 850, Washington, D.C. 20036, TELEPHONE (202) 408-5100, FACSIMILE (202) 408-5200.

See page 2 for signature lines

other side for instructions for completing this form

INSTRUCTIONS FOR COMPLETION OF THIS FORM

line 1 Insert the same title as is used on the specification and in the assignment.

line 2 Is optional but is provided so that you can use it to identify more readily an application prior to the time that the Patent Office application serial number is assigned. We suggest that the specification, drawings and declaration always bear a file number since it can help to get the papers together in case they become inadvertently separated. In instances where the specification is filed without a signed declaration form (under 37 CFR §1.53) a file number on a later-received separate form will assist us in associating it with the correct case.

line 3 Check this box if the specification, claims and drawing (if any) are attached to this declaration form, e.g., when filing a new patent application.

lines 4-5 Are only used in an instance where the application is already on file and the declaration from is being separately filed, e.g.,when the application was originally filed without a signed declaration or where the Patent Office has required a new declaration because of a deficiency in the original declaration. In such an instance the Patent Office will require that lines 4 and 5 be completed with the filing date and application serial number already assigned.

line 6 Is used in conjunction with line 5 but only when there have been one or more amendments to the specification or claims. Line 6 is also used when the Examiner requires a new declaration because claims inserted by amendment cover subject matter not originally claimed (37 CFR §1.67).

lines 7-10 Are for PCT (Patent Cooperation Treaty) cases and are used only when you are entering the U.S. National phase (Chapter I or II) based upon a previously filed PCT International application designating the U.S.

line 7 Check this box if this is a PCT National Phase application.

line 8 Insert PCT International application number.

line 9 Insert date of filing of PCT International application.

lines 10 Insert the date of all amendments filed in the PCT International application. Such amendments are optional, so this line at times will not be used.

line 11a Is used in the following instances:

(i) If a single priority is being claimed from a foreign application you need to list only the first-filed application; you do not need to list other countries if all applications were filed within one year of the U.S. filing.

(ii) If multiple priorities are being claimed, from a plurality of applications filed in one or more countries, you must list the first filed application for each aspect of the invention. Example: if aspect A of the invention was disclosed in an application filed 11 months earlier in country X and aspect B was disclosed 9 months earlier in an application filed in country Y, then the applications in both countries X and Y must be identified. Only the first application for each aspect of the invention needs to be identified provided all applications on that aspect were filed within one year prior to the U.S. filing.

(iii) If a non-priority application is being filed you must list all applications in all countries where corresponding foreign applications were filed more than one year prior to the U.S. filing. This is so the Examiner can check to see if any of those applications were published or patented early enough to be prior art against the U.S. application.

(iv) If there are more than two applications to be listed we suggest that you type in on this form only "See attached Schedule A" and then list all of the previous applications on an attached sheet.

line 11b Is used to claim priority under 35 USC §119(e) based on a provisional application filed within one year of the filing of the instant application. More than one provisional application may be identified provided neither was filed more than one year earlier.

line 12 This block is used only in instances where there is a previously filed U.S. non-provisional application which was copending at the time the present application was (or is being) filed. that previous application could be a U.S. non-provisional application or the National Phase of a PCT allocation. In such a case the present application may be entitled to the priority of the previous application's U.S. filing date (and consequently the foreign priority thereof) provided the present application is identified as a continuing application (continuation, divisional or continuation-in-part) of the earlier (parent) application. If the foregoing is applicable, please fill in one line for each such prior application.

line 13 Type the inventor's proper legal name in the order specified, e.g., "John B. JONES" or "J. Bob JONES" if the inventor so prefers. It is not acceptable to use only initials such as "J. B. JONES."

line 14 The inventor's "signature" may be his (or her) usual manner of signing but it is preferable that the inventor simply write his (or her) name in his (or her) own cursive handwriting in the same order as on line 14, e.g., given name, middle initial and Family name.

line 15 Insert the actual date of signature.

line 16 Insert simply the city and state or country, e.g., "Paris, France", of the inventor's residence, not citizenship. No street address or postal code is required on this line.

line 17 Insert the inventor's citizenship. The statement of citizenship (or subject of) is a statutory requirement (35 USC §115). Simply the name of the country of citizenship, e.g., "Japan" is sufficient.

line 18 Insert the inventor's mailing address. The purpose of requiring the post office address is to enable the Patent Office to communicate directly with the inventor if desired, such as in the case of death of the U.S. attorney. It should be the address where the inventor customarily receives his (or her) mail and should include the postal code. If applicable it can be the inventor's business address or address at place of employment.

Applicants are reminded that the U.S. Patent and Trademark Office has very strict requirements as to proper execution of an application. The applicant should make sure that he reviews the declaration, prior to signing to make sure the declaration properly identifies the application and all relevant information; and should review the specification and claims (including drawings, if any) before signing the declaration. Failure to do so will require the filing of a supplemental declaration --- 37 CFR §1.67(c)

Any handwritten changes to the specification, claims or drawings must be in ink personally by all of the inventors prior to signing the declaration and the adjacent left margin must be initialed and dated by all of the inventors, e.g., "JBJ 6-9-91".

Please let us know if there are any questions regarding proper completion of this form. Thank you.

An assignment, a separate document requiring separate signature and dating may be enclosed. Please look for it and sign and date it in the same manner as in lines 15 and 16 above.

STEVENS, DAVIS, MILLER & MOSHER, L.L.P.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

PAGE 2 OF U.S.A. DECLARATION FORM

13a	Typewritten Full Name of Sole or First Inventor 1-ED	**Kenichi** (Given Name)	(Middle Name)	**MIYOSHI** (Family Name)
14a	Inventor's Signature	Kenichi		Miyoshi
15a	Date of Signature	April (Month)	17 (Day)	2001 (Year)
16a	Residence	**Yokohama-shi** (City)	**Kanagawa** (State or Province)	**JAPAN** (Country)
17a	Citizenship	**JAPAN**		JPX
18a	Post Office Address *(Insert complete mailing address, including country)*	**1-240-1-501, Mutsukawa, Minami-ku,** **Yokohama-shi, Kanagawa 232-0066 JAPAN**		
13b	Typewritten Full Name of Sole or Second Inventor	Given Name	Middle Name	Family Name
14b	Inventor's Signature			
15b	Date of Signature	Month	Day	Year
16b	Residence	City	State or Province	Country
17b	Citizenship			
18b	Post Office Address *(Insert complete mailing address, including country)*			
13c	Typewritten Full Name of Sole or Third Inventor	Given Name	Middle Name	Family Name
14c	Inventor's Signature			
15c	Date of Signature	Month	Day	Year
16c	Residence	City	State or Province	Country
17c	Citizenship			
18c	Post Office Address *(Insert complete mailing address, including country)*			
13d	Typewritten Full Name of Sole or Fourth Inventor	Given Name	Middle Name	Family Name
14d	Inventor's Signature			
15d	Date of Signature	Month	Day	Year
16d	Residence	City	State or Province	Country
17d	Citizenship			
18d	Post Office Address *(Insert complete mailing address, including country)*			

*Note to Inventor: Please sign name on line 15 exactly as it appears in line 14 and insert the actual date of signing on line 16. If there are more than four inventors, please add a copy of this page for identification and signatures for the additional inventors.